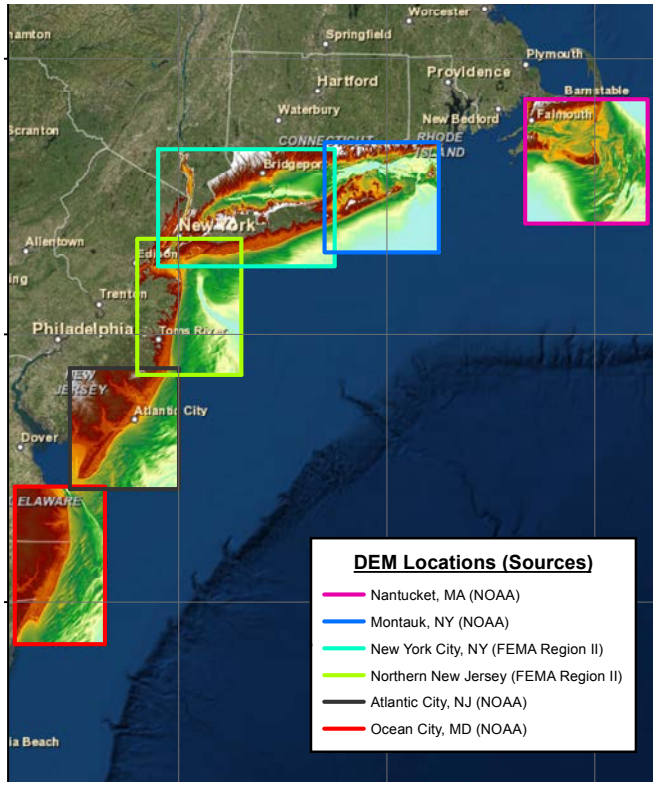
UNIVERSITY of DELAWARE

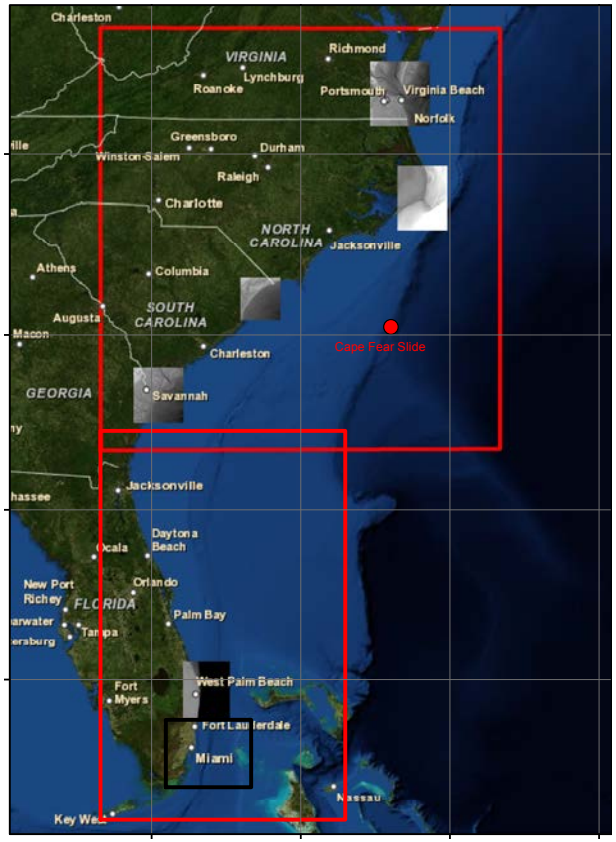
Does Morphological Adjustment During Tsunami Inundation Increase Levels of Hazard?

Babak Tehranirad, James T. Kirby,
Fengyan Shi, and Stephan T. Grilli

Center for Applied Coastal Research

- The National Tsunami Hazard Mitigation Program (NTHMP) is mandated to conduct tsunami hazard analysis for all US coastlines (Stephan Grilli's Talk on Wednesday).
- NTHMP provides high-resolution DEMs of vulnerable areas of the US East Coast for tsunami hazard assessment.





Phase I (North Atlantic)

- Nantucket, MA
- Montauk, NY
- New York City, NY
- Northern New Jersey
- Atlantic City, NJ
- Ocean City, MD

Phase II (Mid/South- Atlantic)

- Virginia Beach, VA
- Cape Hatteras, NC
- Myrtle Beach, SC
- Savannah Beach, GA
- Daytona Beach, FL
- Palm Beach, FL
- Miami, FL

- Present inundation mapping uses a fixed bathymetry/topography as basis for modeling.
- Significant morphological changes can occur to bathymetry and topography during the course of an event.
- Models based on fairly standard versions of sediment transport in shallow flows have skill in predicting patterns and magnitudes of topo/bathy change

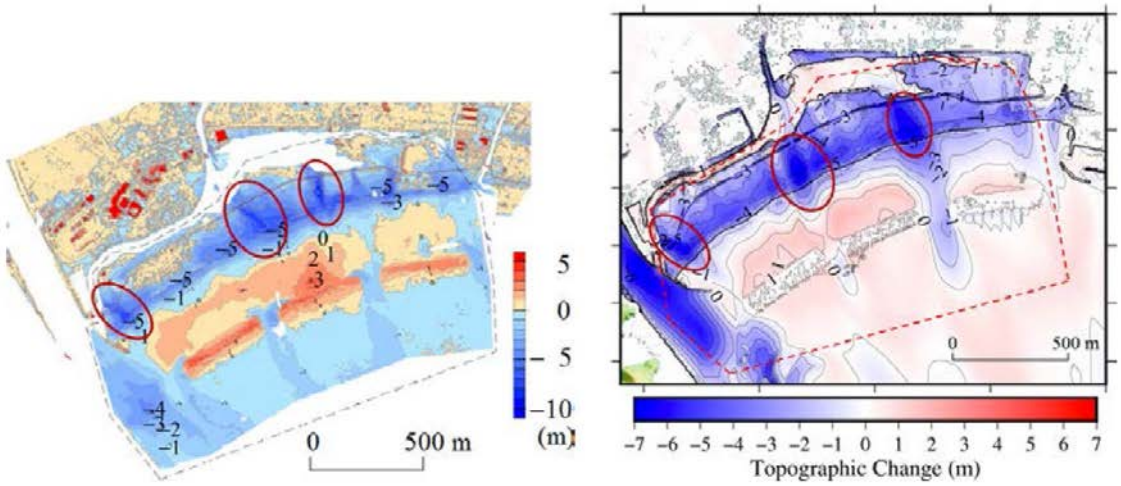
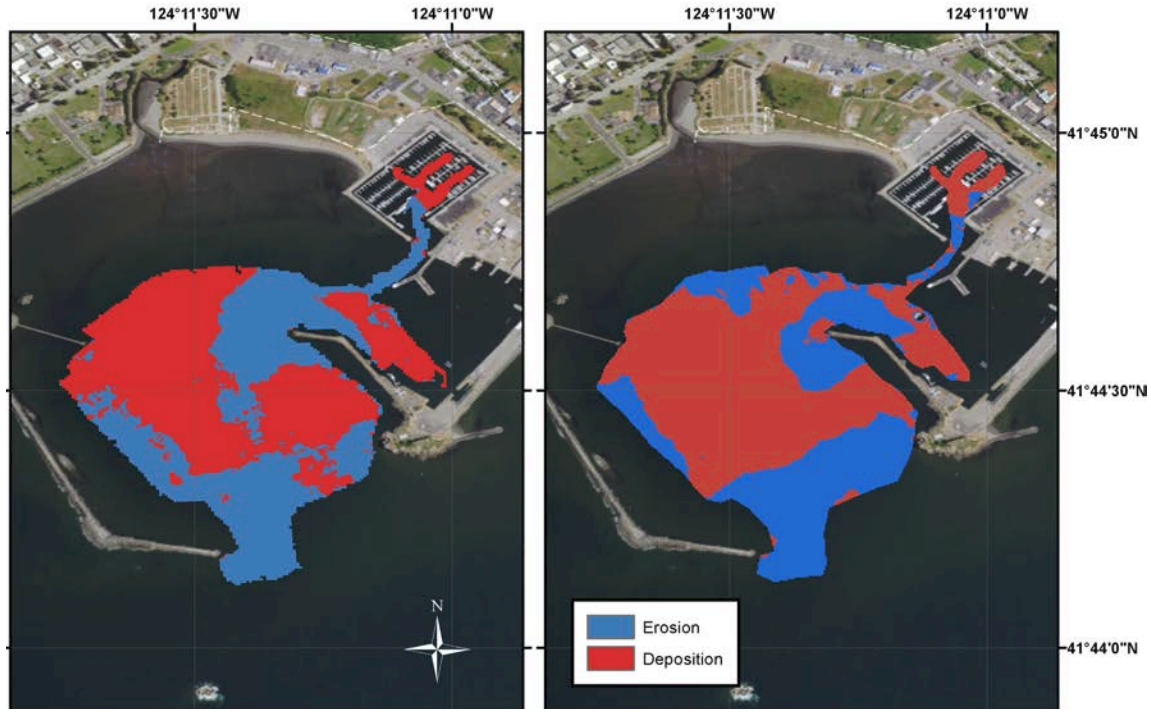


Fig. 8. (Color online) Topographic changes before and after the tsunami, where the ground elevation change excludes subsidence due to the earthquake. (a) Field survey by Kato *et al.* [2012], which was conducted in May 2011, following the earthquake. (b) Simulation from this study using the STM and based on a scenario in which the first and second dikes break.

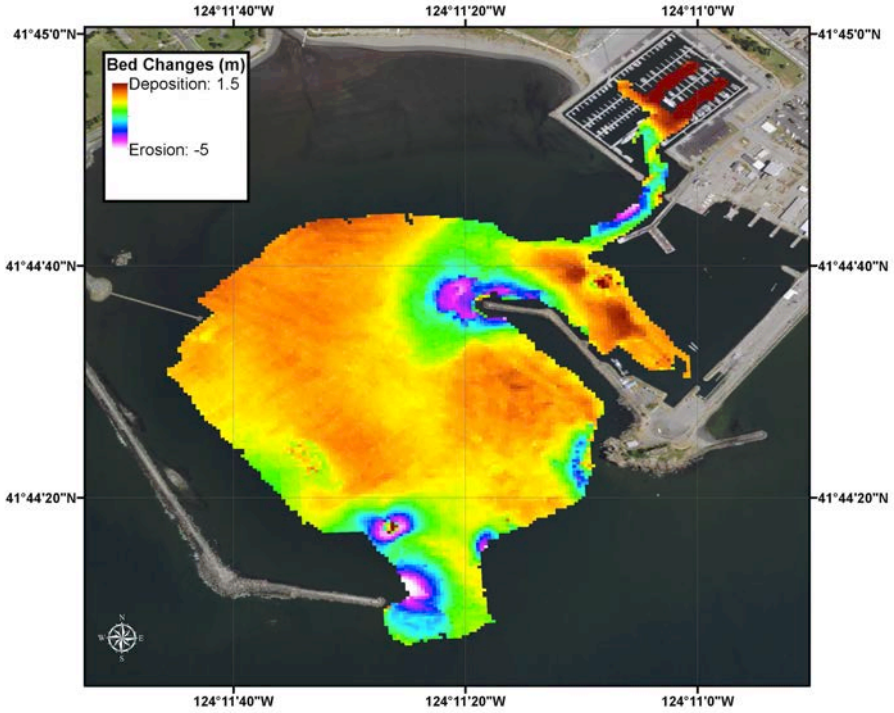
Yamashita et al. (2016)

- Do these changes during the ongoing event affect the extent of inundation resulting from the event?
- Approach: Coupled model based on:
  - Boussinesq model FUNWAVE for hydrodynamics
  - Depth-integrated model for suspended sediment transport
    - Modifications to address details such as non-erodible beds, limited depths of available sediment slope limitations.
- Skill assessment: Simulation of Crescent City Harbor during 2011 Tohoku event

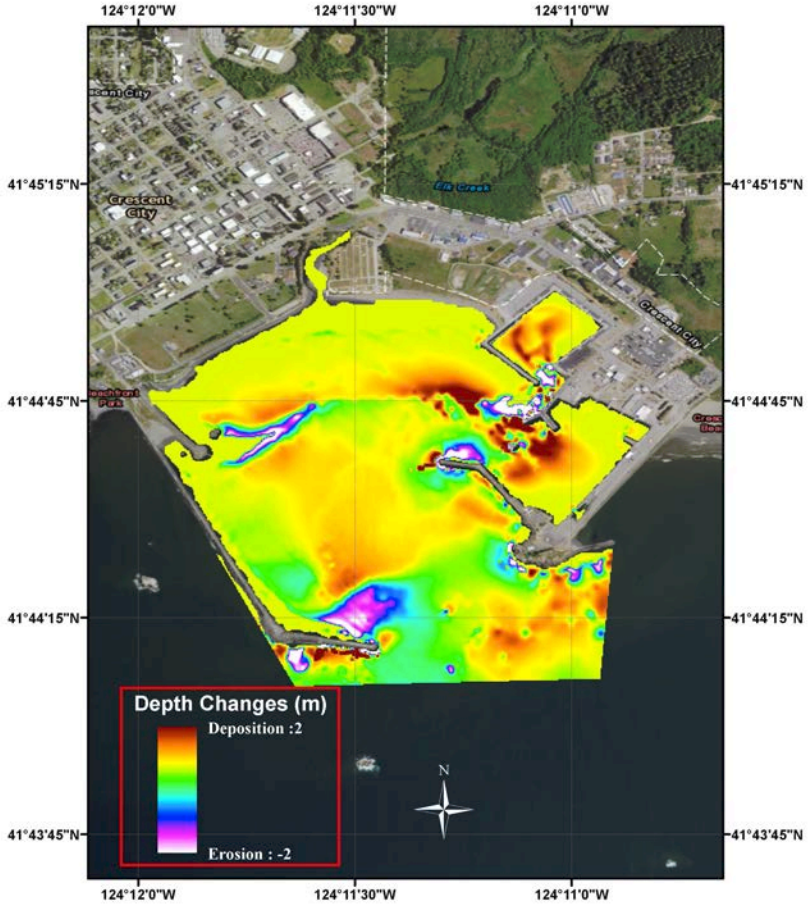
Wilson et al. (2012)



Computed



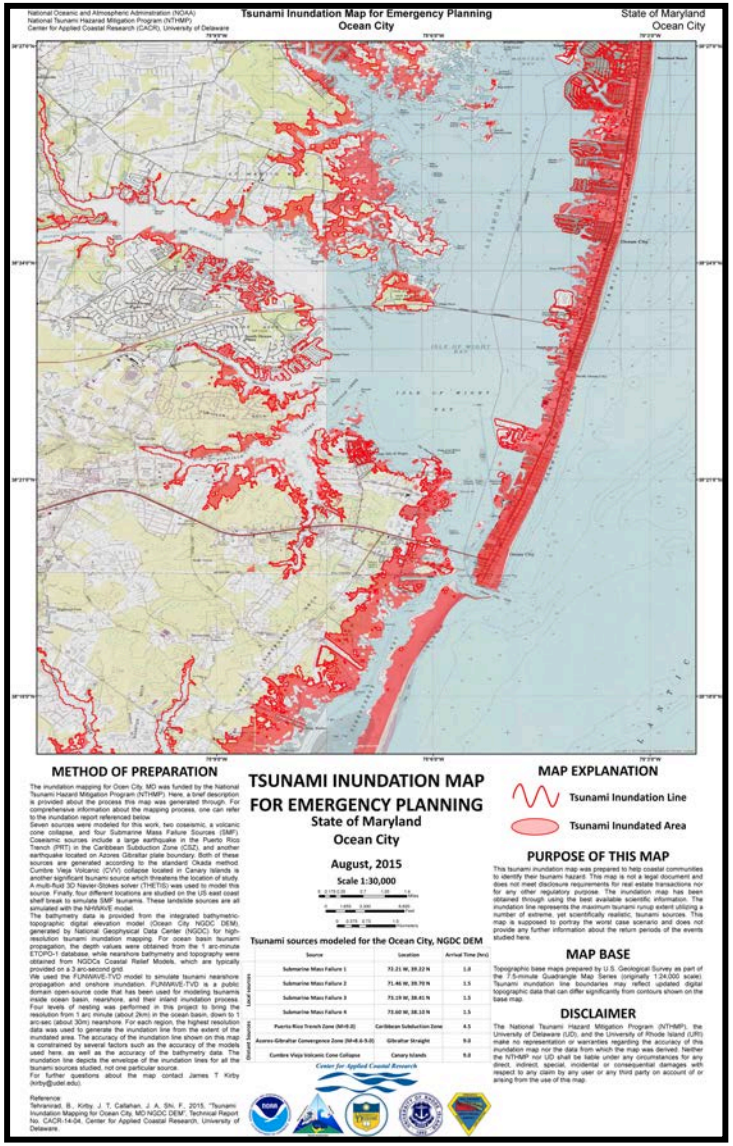
Measured (Wilson et al., 2012)



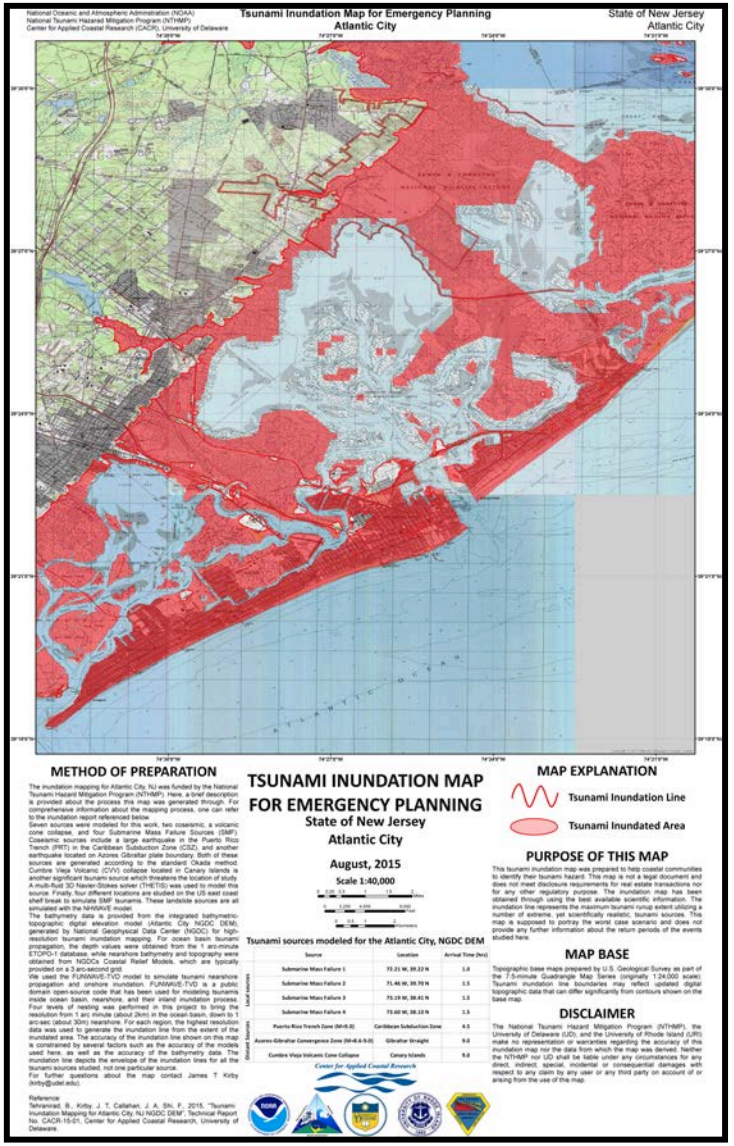
Calculated

Example of effect in already-modeled areas

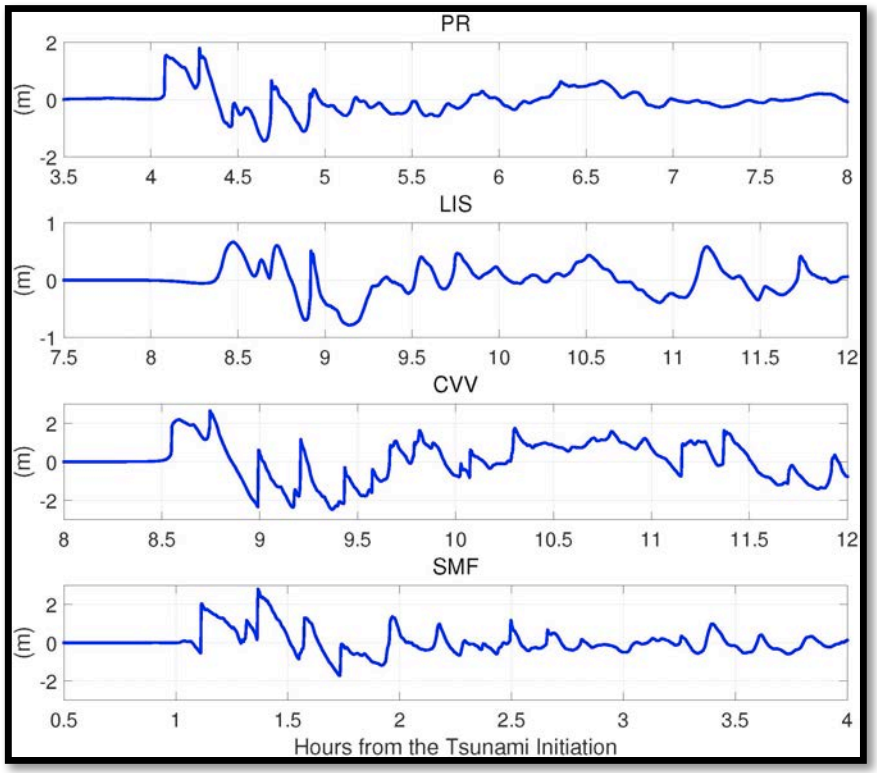
Ocean City, MD

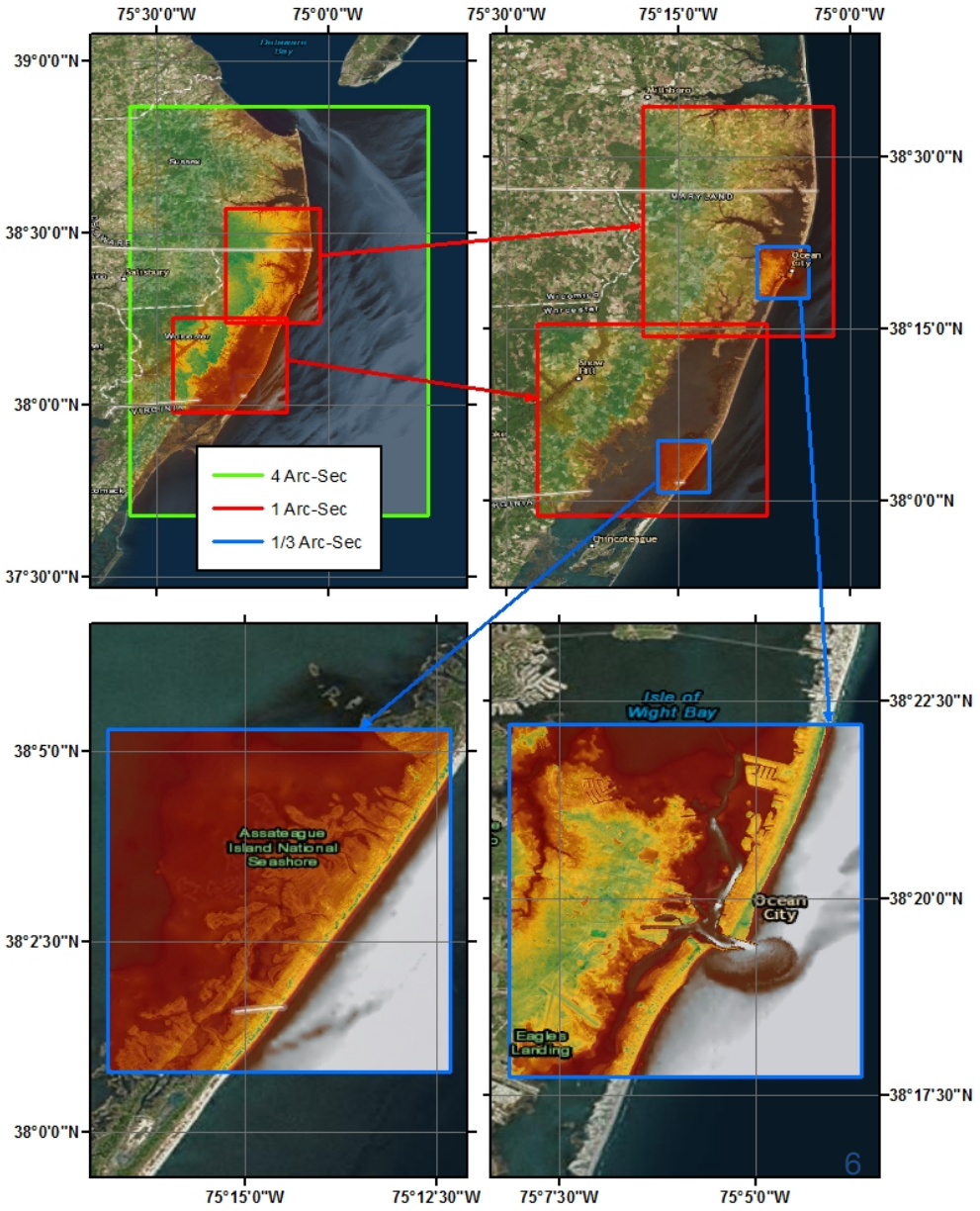


Atlantic City, NJ



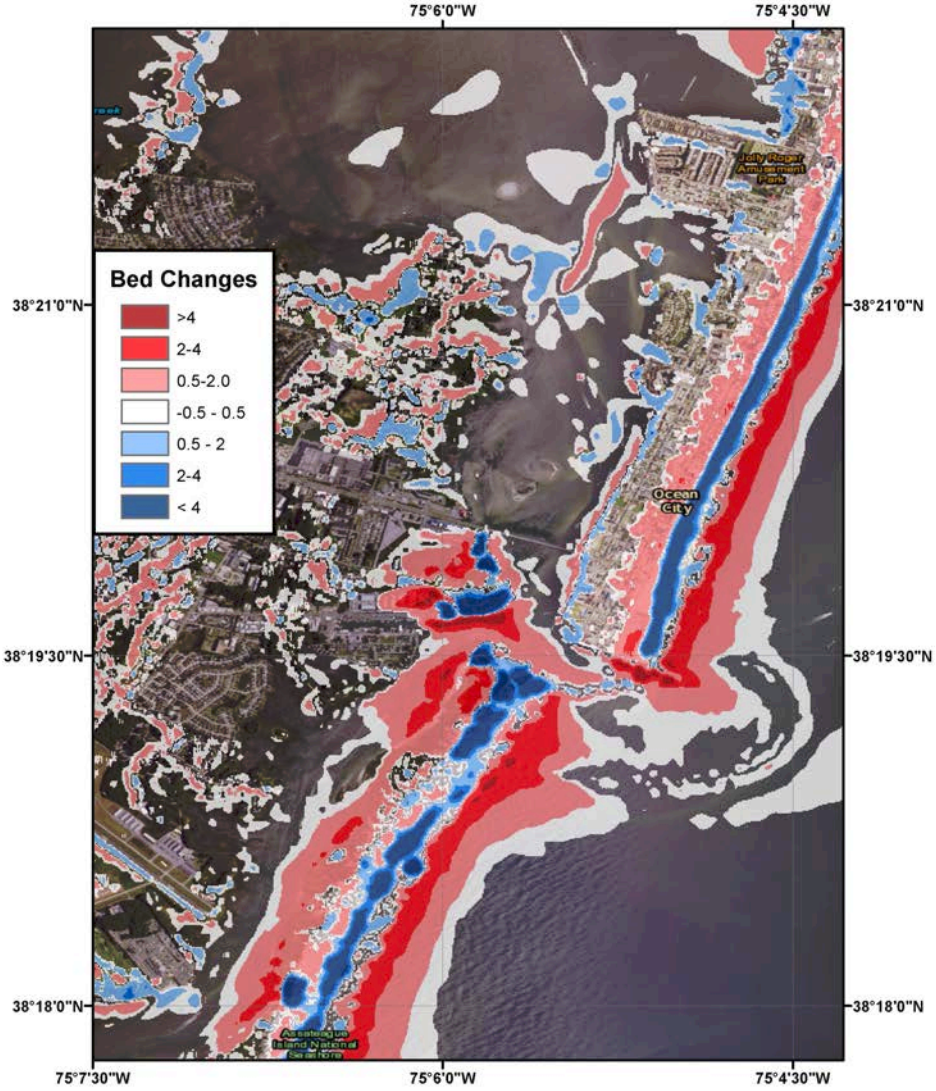
Modeling Tsunami on Assateague Island and Ocean City Barrier Islands



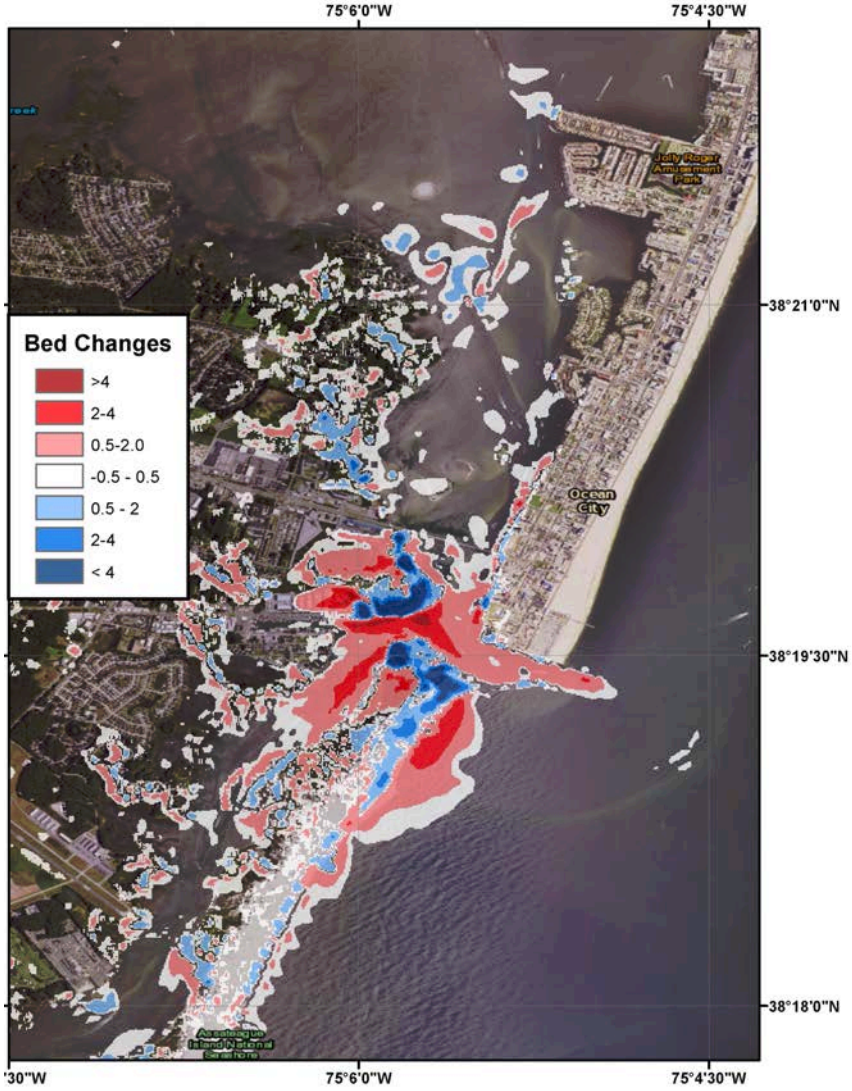


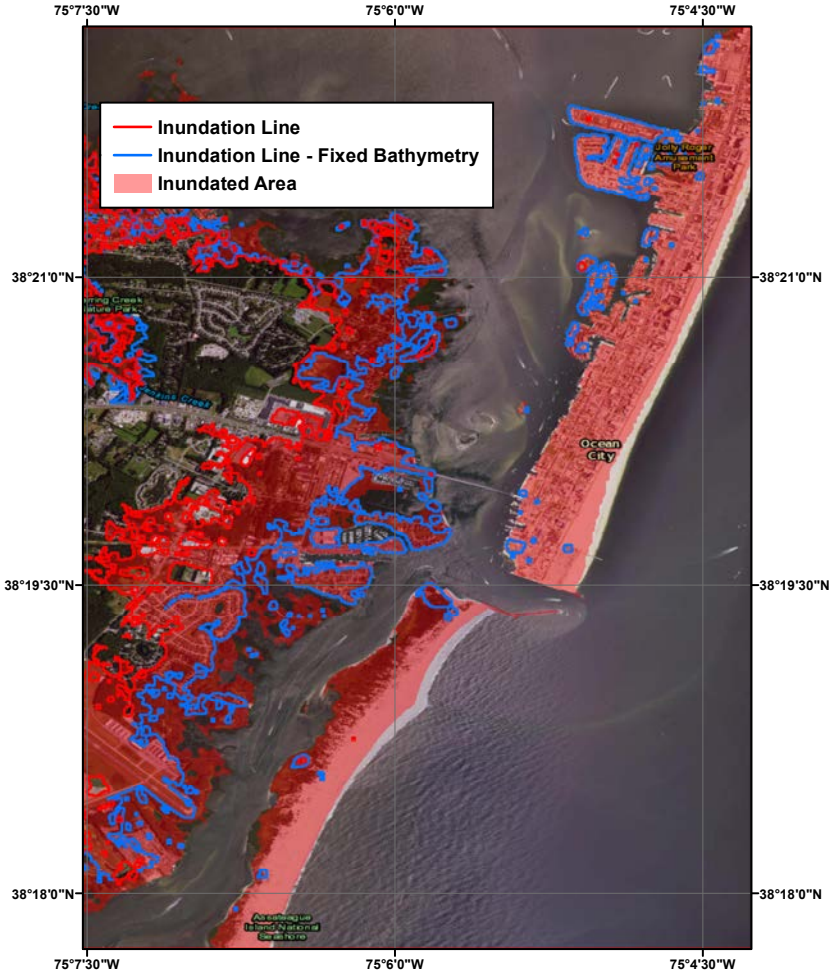
Ocean City MD: Grid configuration for sediment transport model

Cumbre Vieja (80 km^3)

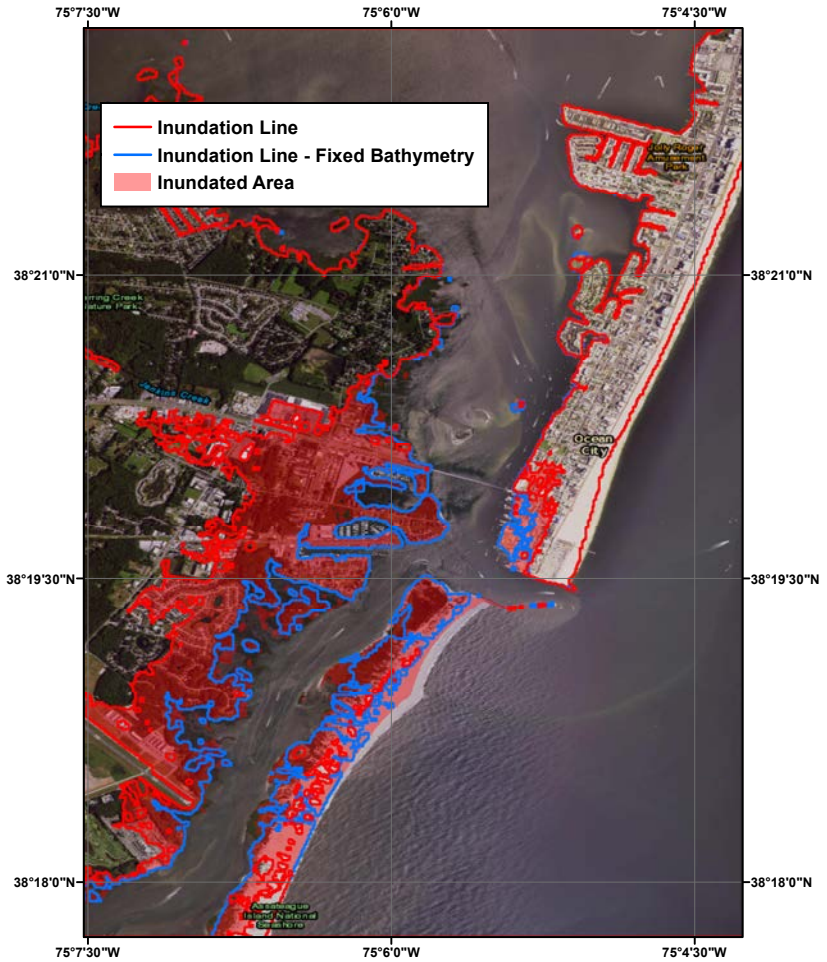


Lisbon Earthquake





Currituck-like event



Lisbon event

Resulting changes in inundated areas

Tsunami	Inundated Area (Static)	Inundated Area (Dynamic)	Inundation Area Increase (%)
Puerto Rico	7.03 km^3	10.61 km^3	51
Landslide	9.46 km^3	13.43 km^3	42
Volcanic cone collapse	10.94 km^3	19.25 km^3	76
Lisbon	1.28 km^3	7.02 km^3	547

- Morphology change during events potentially leads to large increases in estimates of extent of inundation
- Results for small(er) events can show the greatest increase, if barrier island breaches or other similar changes occur.
- This result could have a strong impact on PTHA-based inundation estimates.